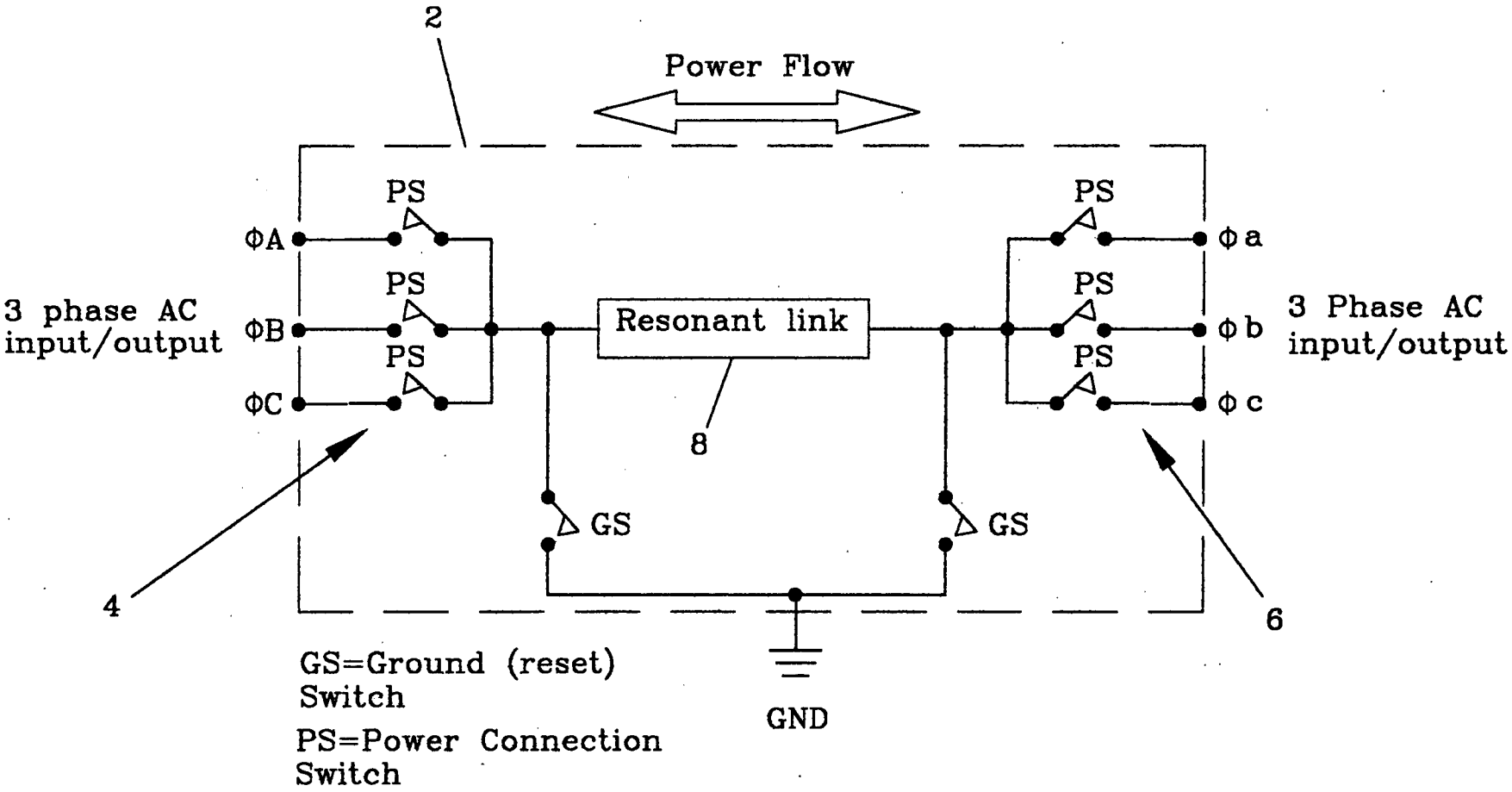

2
Power Flow
PS
ΦA
PS
3 phase AC
input/output
ΦB
PS
ΦC
Resonant link
8
PS
Φa
PS
Φb
PS
Φc
3 Phase AC
input/output
GS
GS
4
6
GS=Ground (reset)
Switch
PS=Power Connection
Switch
GND

FIG. 1A

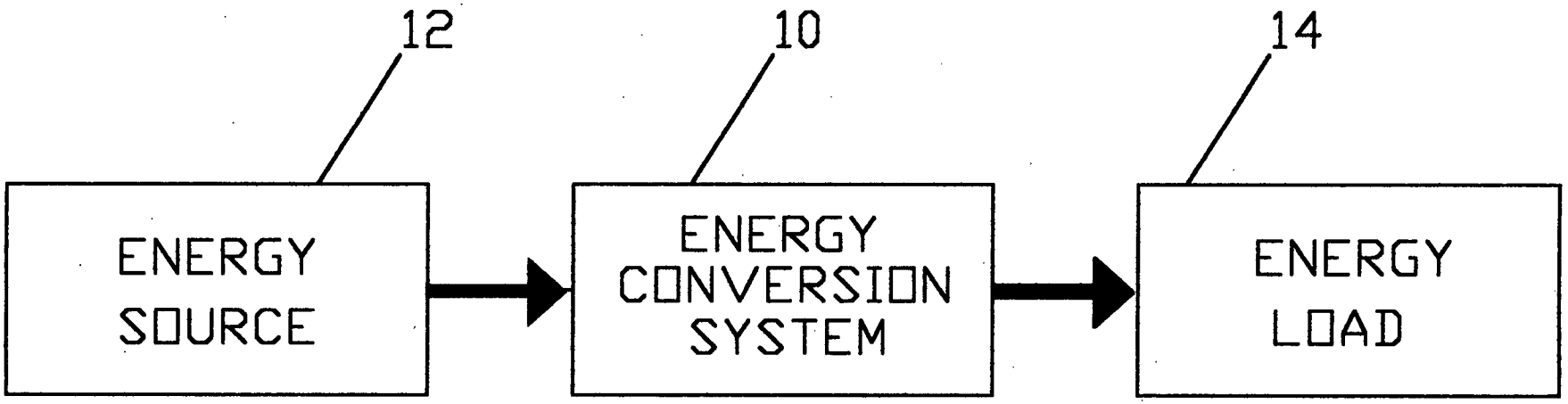

12
10
14
ENERGY SOURCE
ENERGY CONVERSION SYSTEM
ENERGY LOAD

FIG. 1B

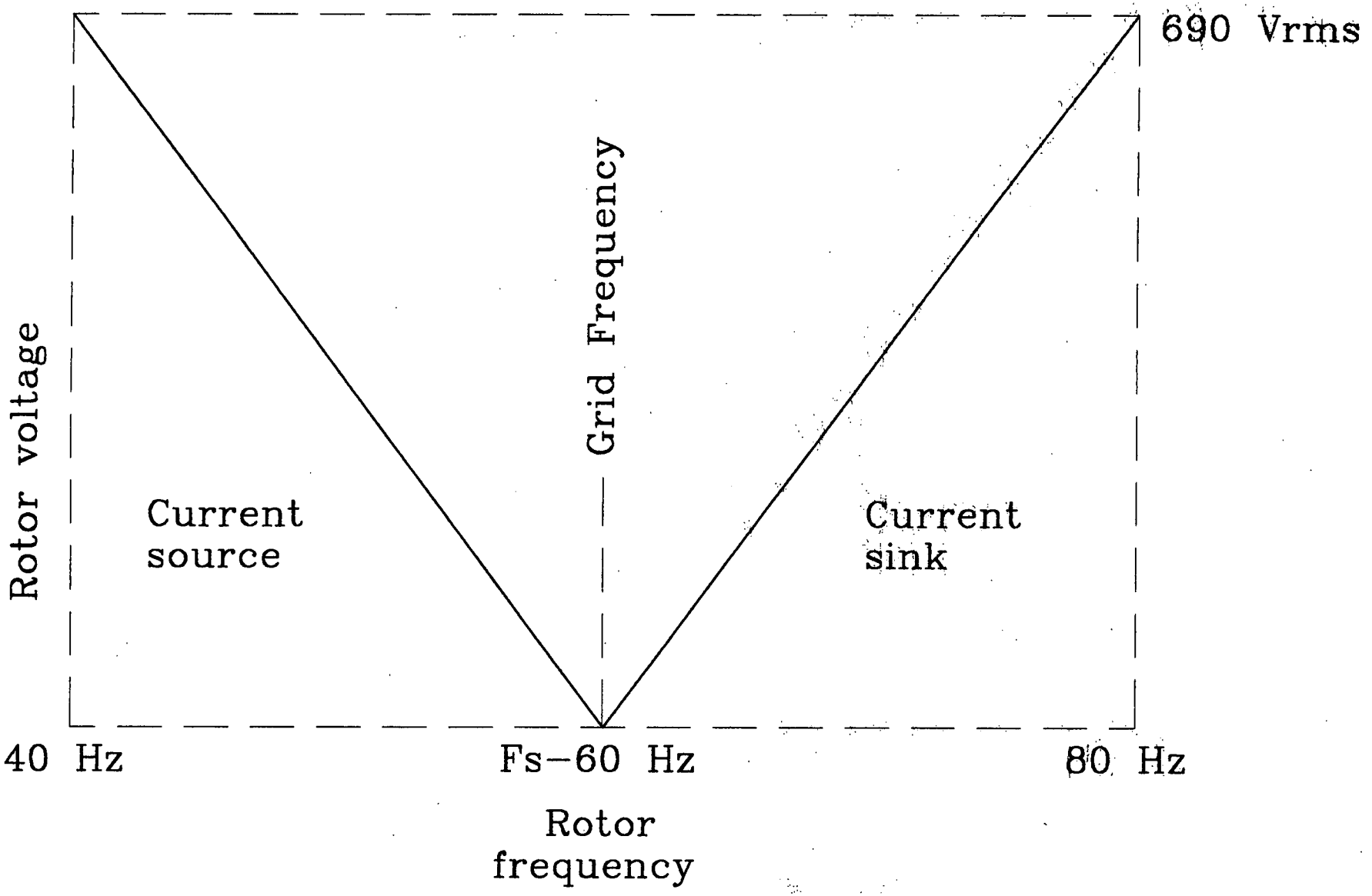

690 Vrms
Rotor voltage
Grid Frequency
Current
source
Current
sink
40 Hz
Fs−60 Hz
80 Hz
Rotor
frequency

FIG. 2A

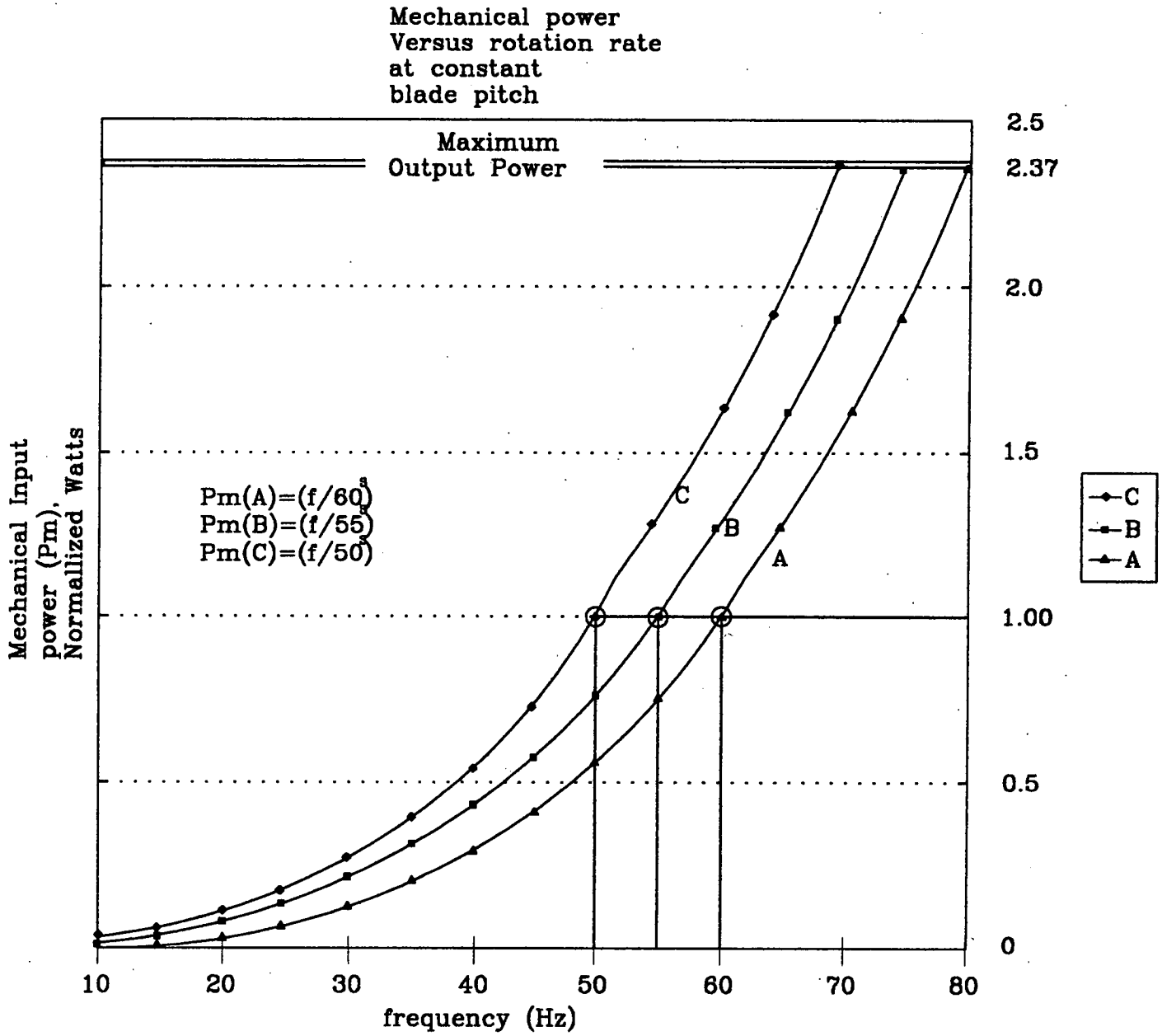

Mechanical power
Versus rotation rate
at constant
blade pitch
Maximum
Output Power
2.5
2.37
2.0
1.5
1.00
0.5
0
Mechanical Input
power (Pm),
Normallized Watts
Pm(A)=(f/60)^3
Pm(B)=(f/55)^3
Pm(C)=(f/50)^3
C
B
A
10
20
30
40
50
60
70
80
frequency (Hz)

FIG. 2B

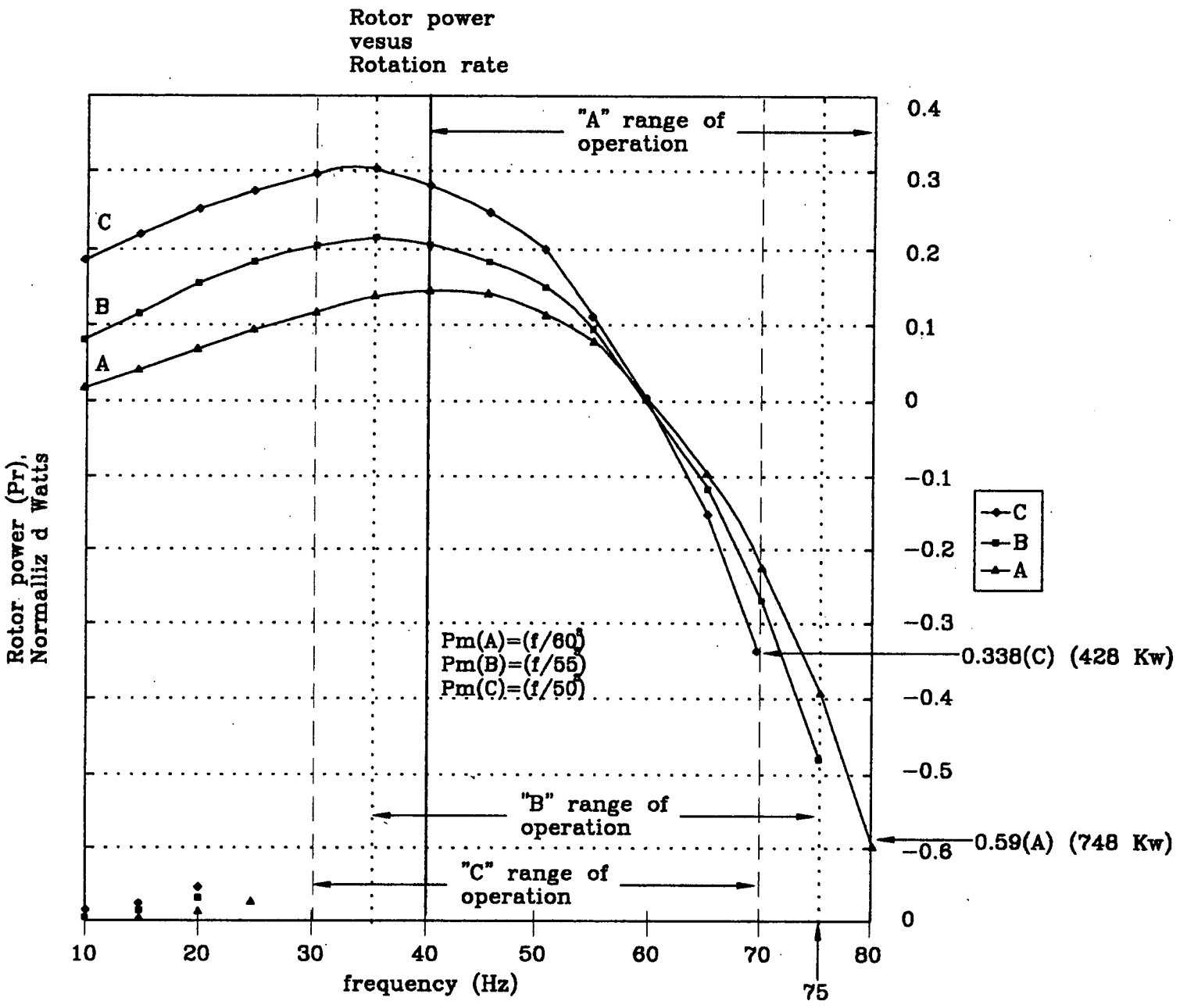

Rotor power
vesus
Rotation rate
"A" range of
operation
C
B
A
Pm(A)=(f/60)
Pm(B)=(f/55)
Pm(C)=(f/50)
0.338(C) (428 Kw)
0.59(A) (748 Kw)
"B" range of
operation
"C" range of
operation
Rotor power (Pr),
Normaliz d Watts
frequency (Hz)
0.4
0.3
0.2
0.1
0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
0
10
20
30
40
50
60
70
80
75
C
B
A

FIG. 2C

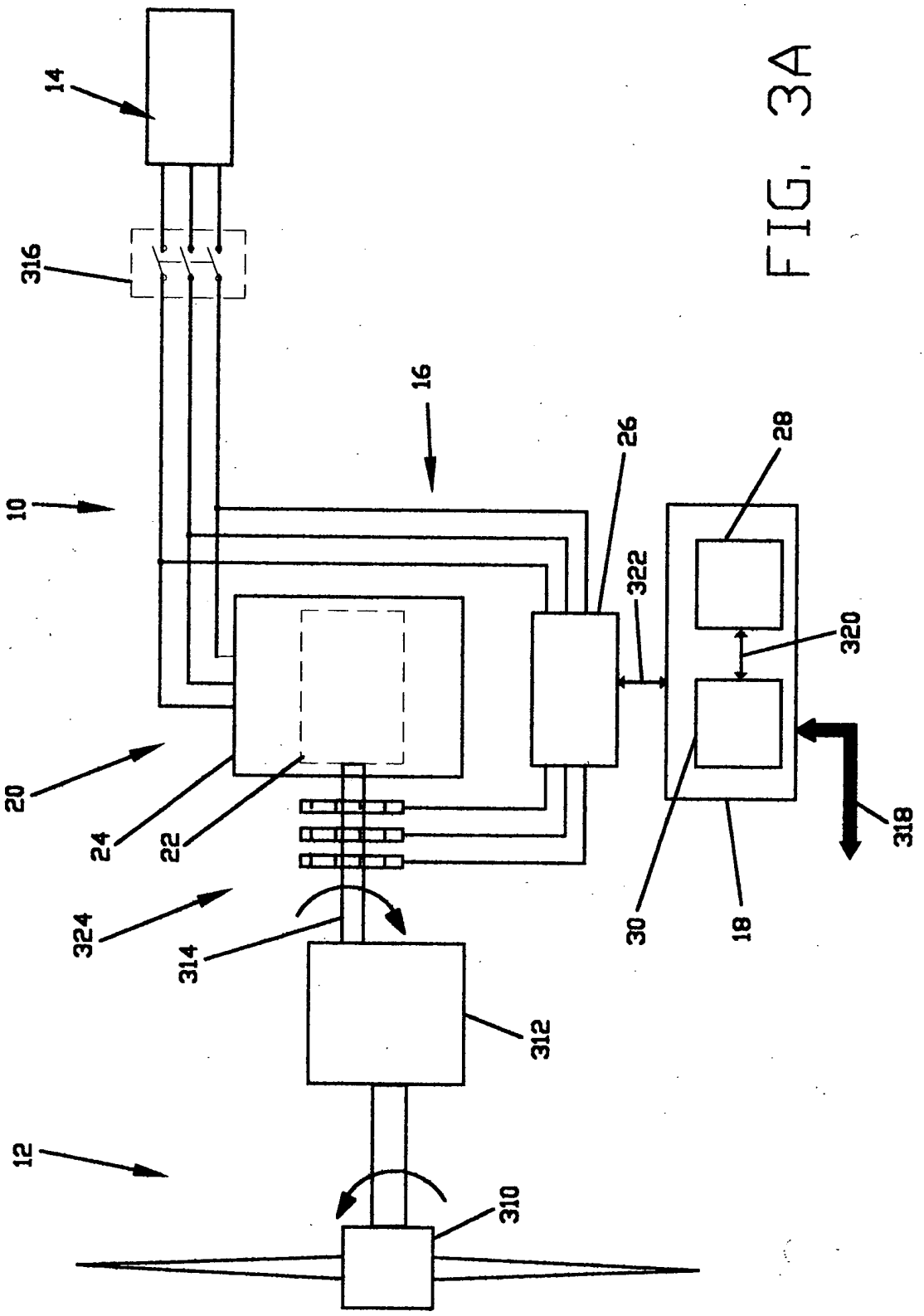


FIG. 3A

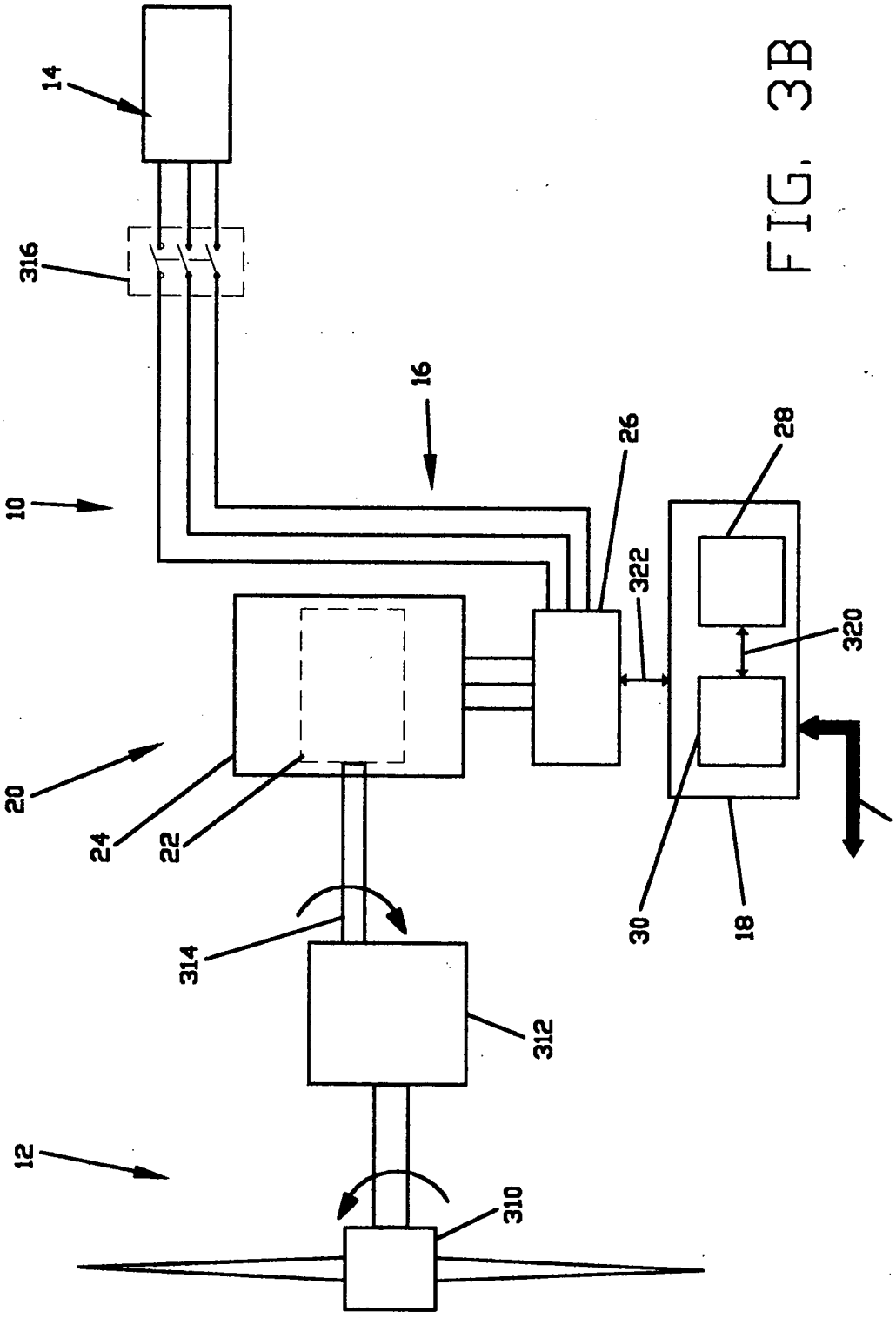


FIG. 3B

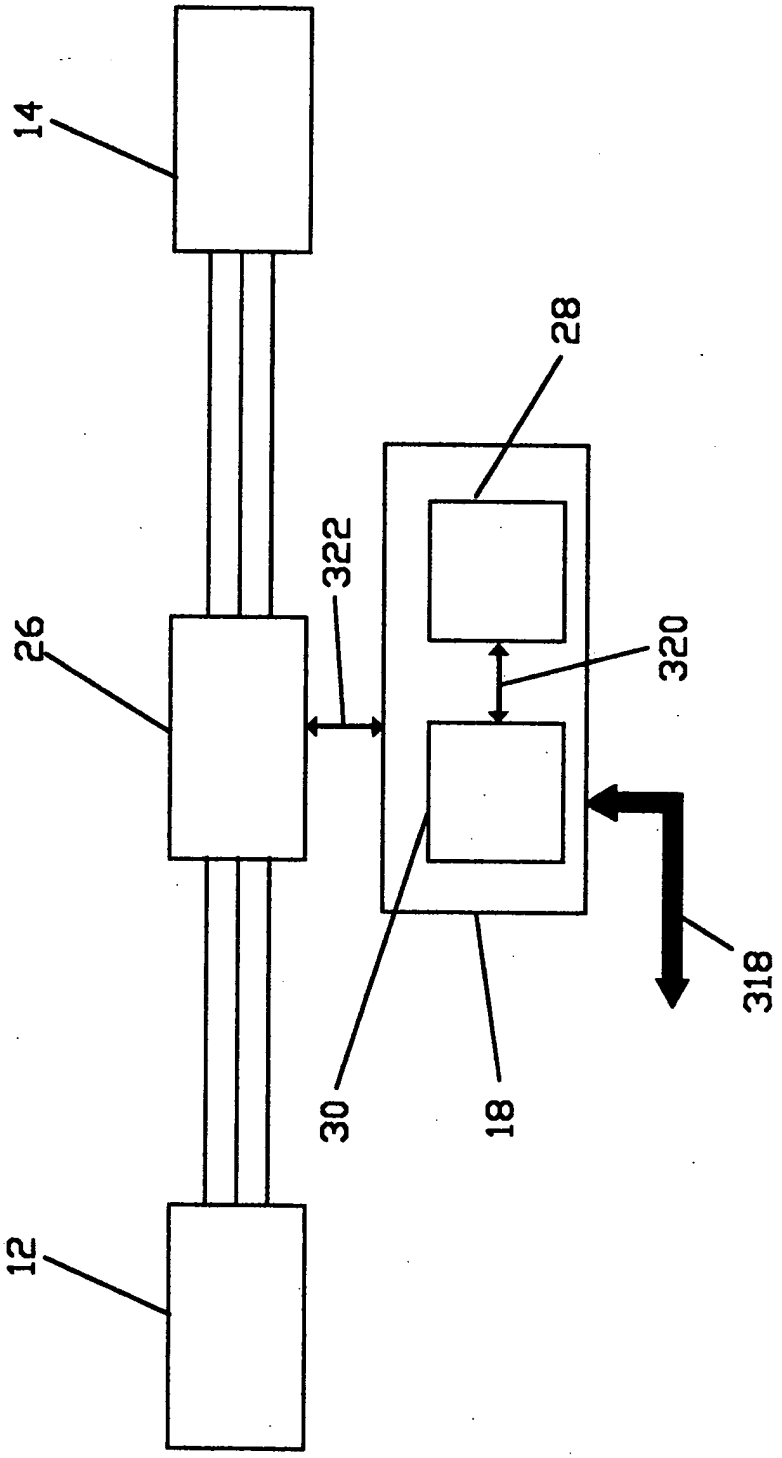


FIG. 3C

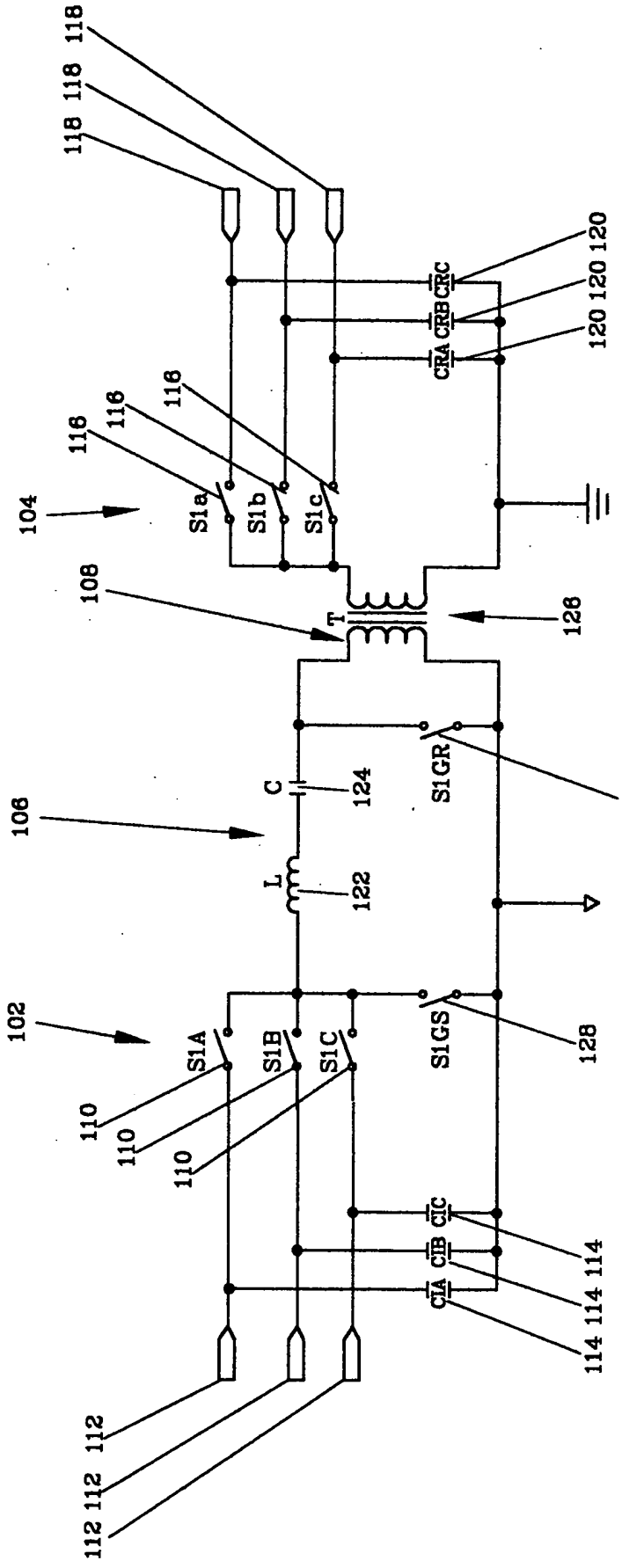

118
118
118
120
120
120
CRA
CRB
CRC
116
116
116
S1a
S1b
S1c
104
108
T
126
C
124
S1GR
130
106
L
122
102
S1A
S1B
S1C
S1GS
128
110
110
110
CIA
CIB
CIC
114
114
114
112
112
112

FIG. 4

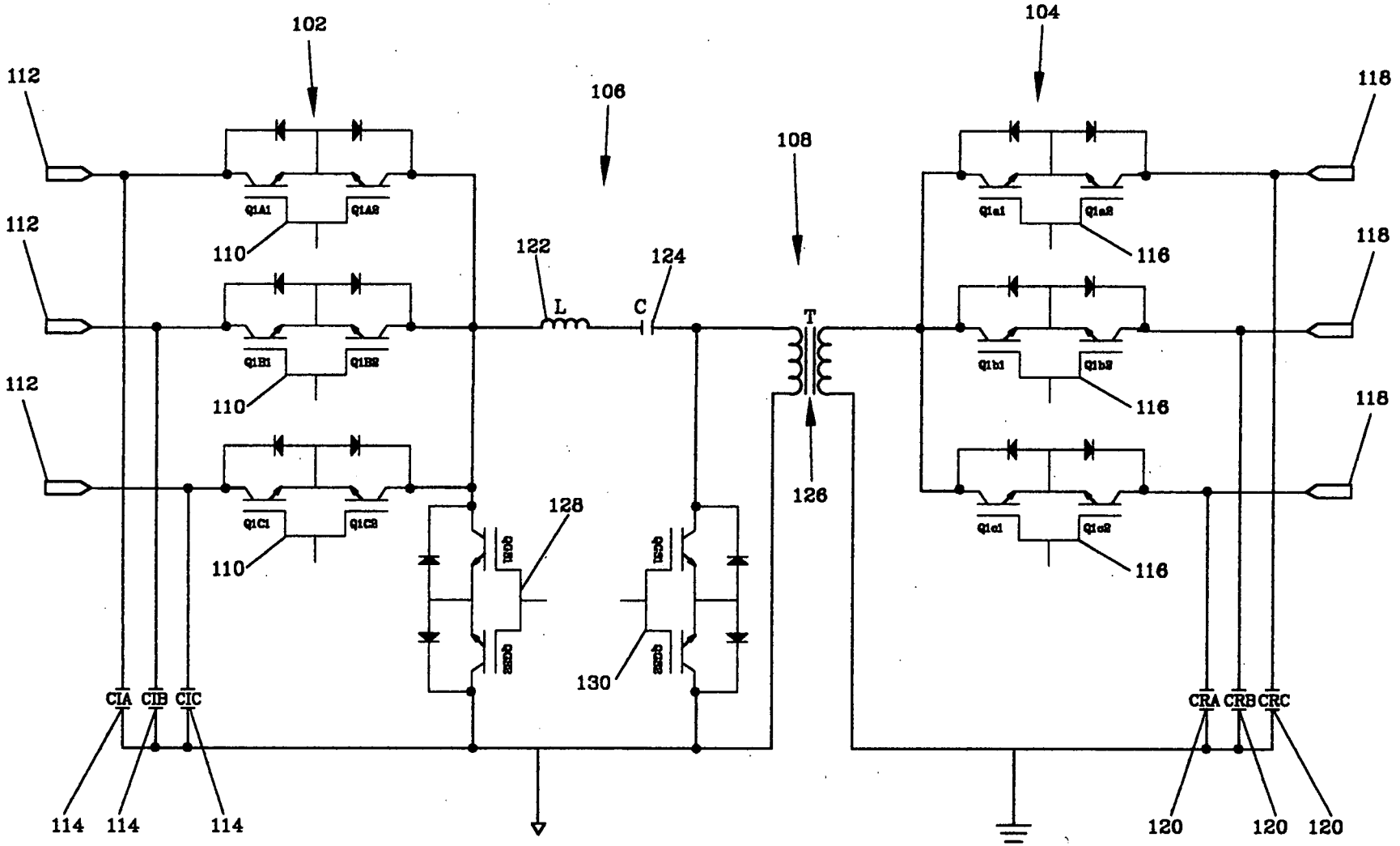

102
104
106
108
112
112
112
110
110
110
122
L
124
C
T
126
128
130
116
116
116
118
118
118
CIA
CIB
CIC
CRA
CRB
CRC
114
114
114
120
120
120

FIG. 5

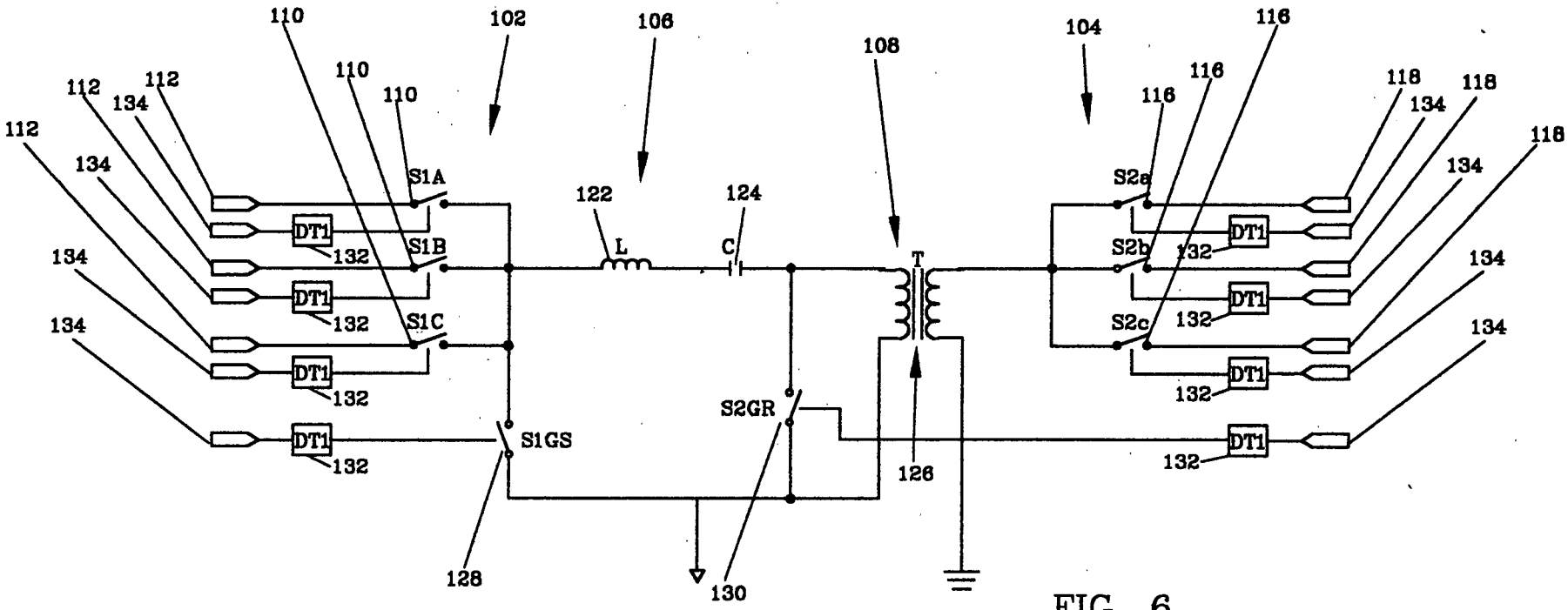

110
102
106
108
104
116
112
110
116
118
112
134
110
116
118
112
S1A
S2a
134
134
122
124
134
DT1
132
S1B
L
C
T
S2b
DT1
132
134
134
S1C
S2c
DT1
132
DT1
132
134
S2GR
S1GS
DT1
132
DT1
132
126
128
130

FIG. 6

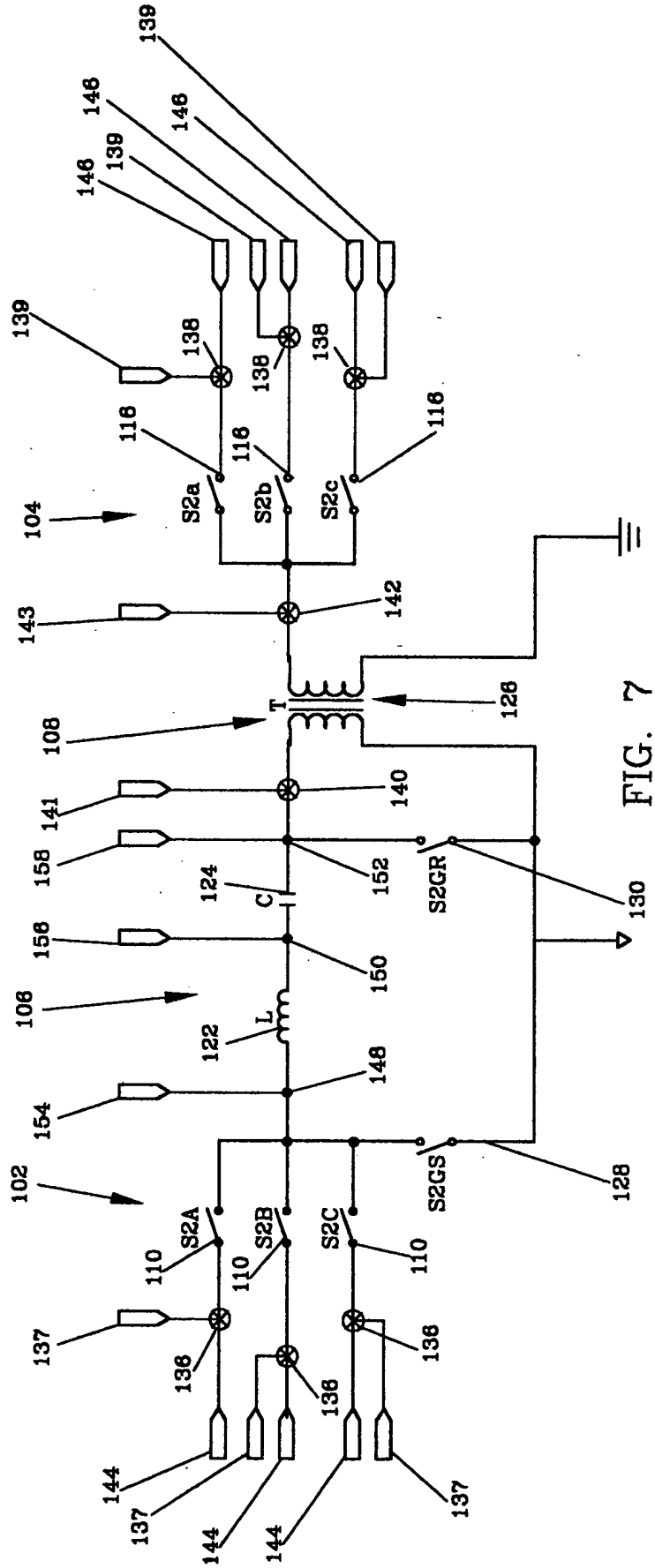

139
146
146
139
146
139
138
138
138
116
116
116
S2a
S2b
S2c
104
143
142
T
126
108
141
140
158
152
S2GR
130
124
C
158
150
106
L
122
148
154
102
S2A
S2B
S2C
S2GS
128
110
110
110
137
136
136
138
144
137
144
144
137

FIG. 7

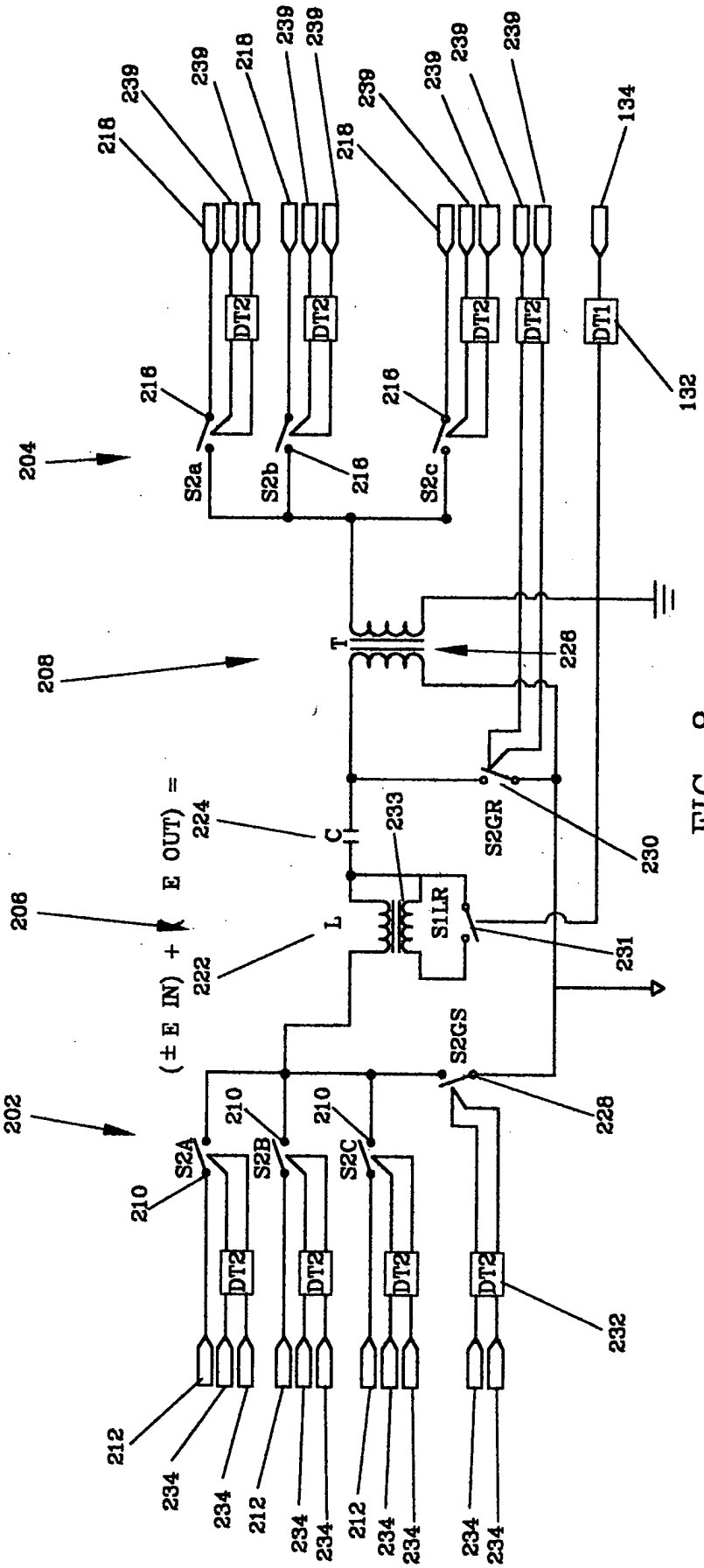

202
204
206
208
(± E IN) + (± E OUT) =
L
C
T
S1LR
S2GR
S2GS
S2A
S2B
S2C
S2a
S2b
S2c
DT1
DT2
132
134
210
212
216
218
222
224
228
230
231
232
233
234
239

FIG. 8

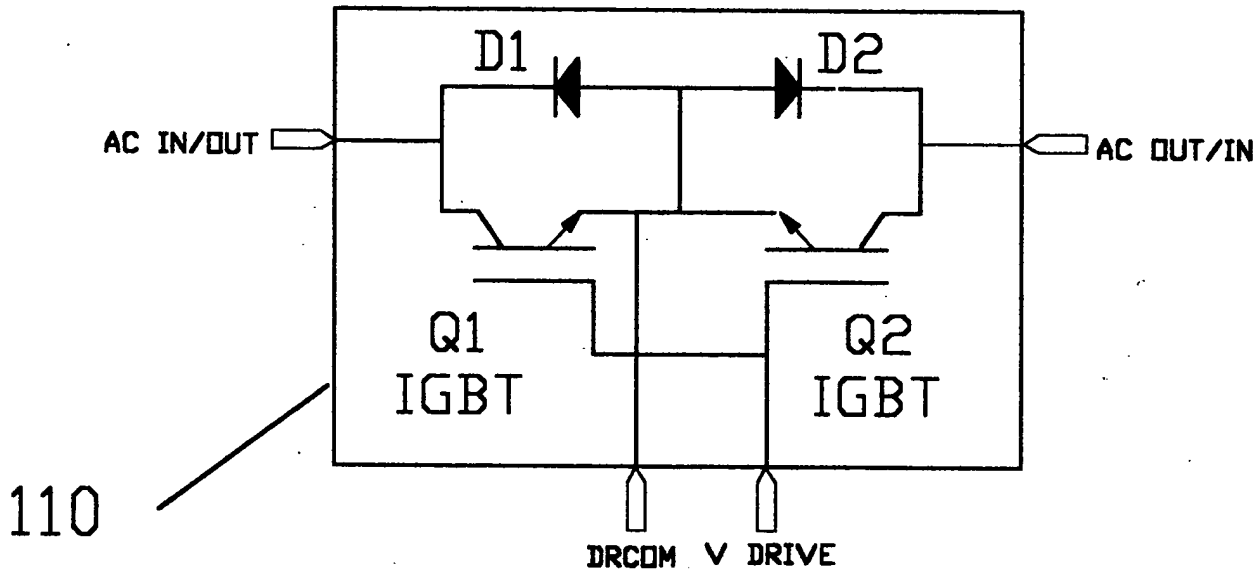

D1
D2
AC IN/OUT
AC OUT/IN
Q1
IGBT
Q2
IGBT
110
DRCOM
V DRIVE

FIG. 9

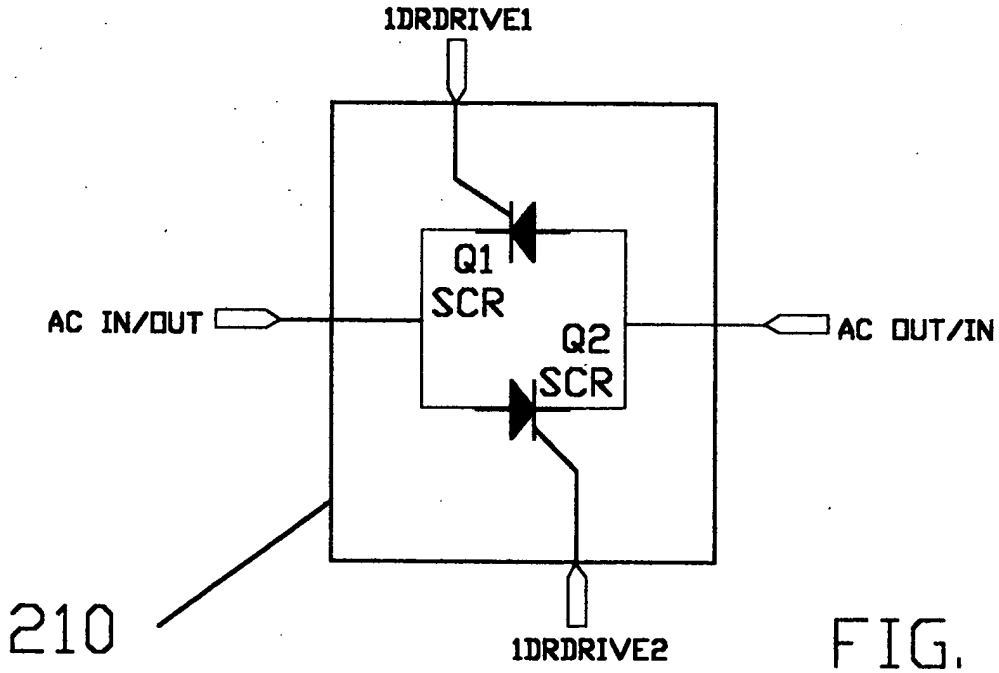

1DRDRIVE1
Q1
SCR
Q2
SCR
AC IN/OUT
AC OUT/IN
210
1DRDRIVE2

FIG. 10

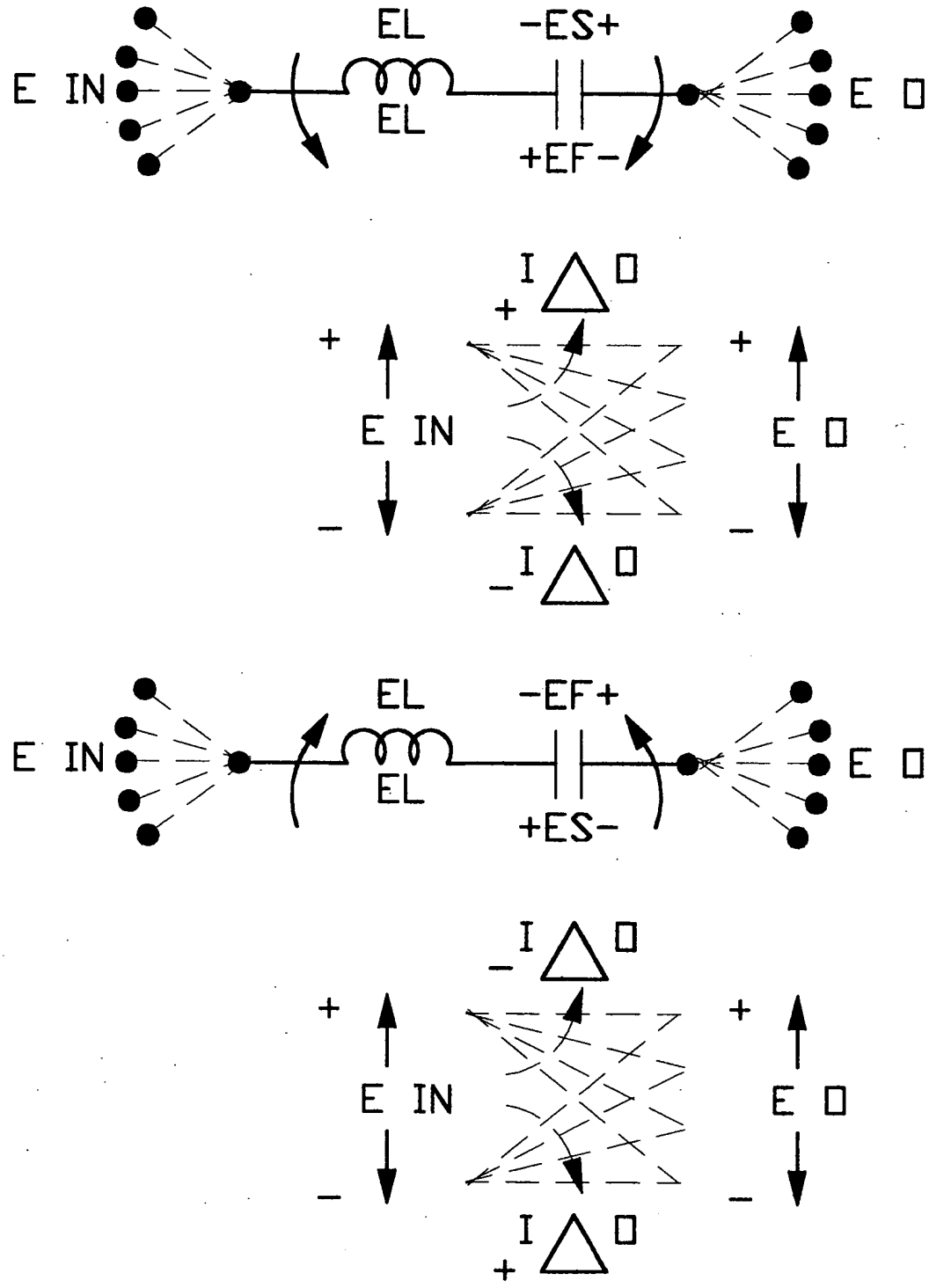


FIG. 11

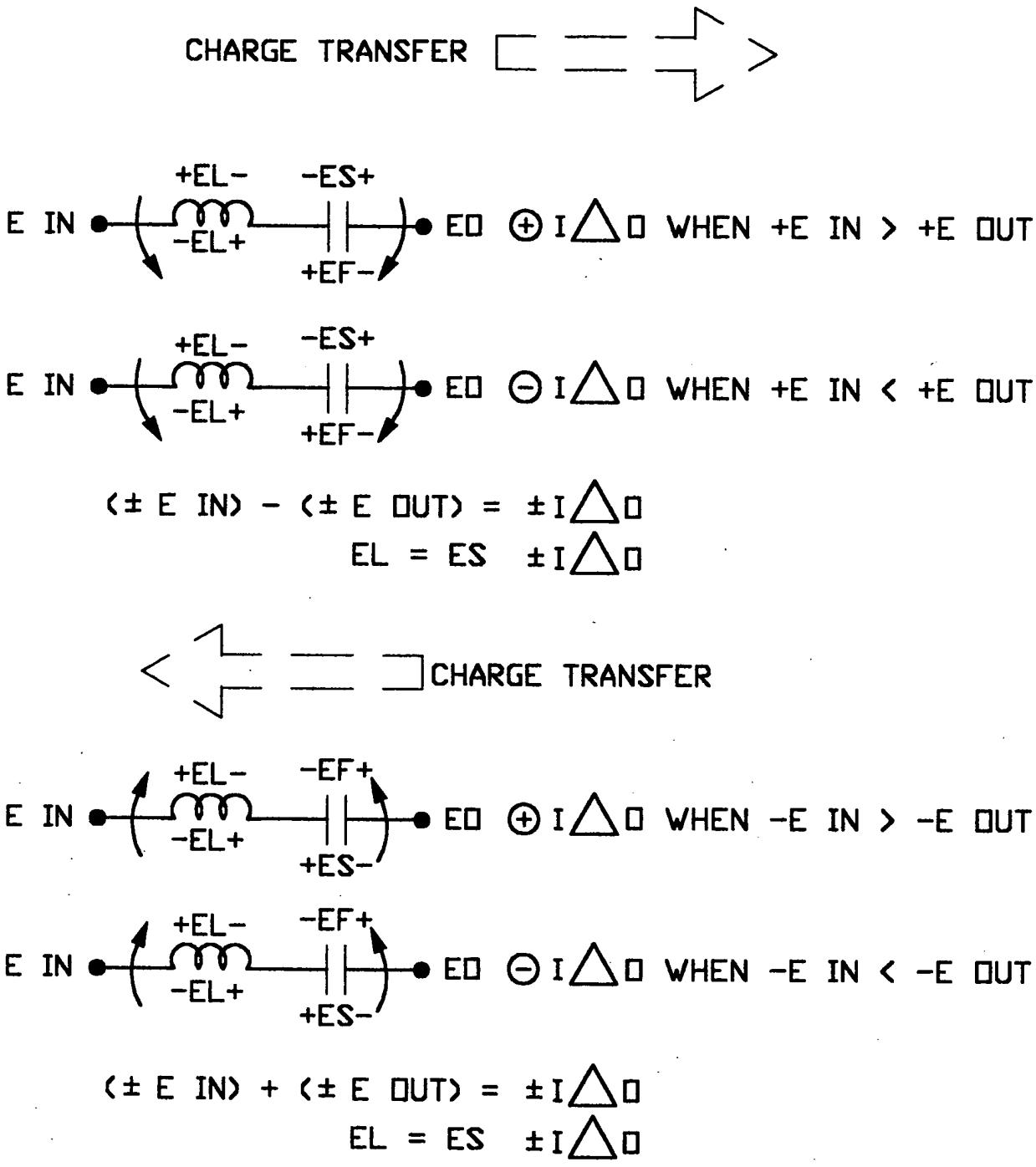

CHARGE TRANSFER
+EL-
-ES+
E IN
-EL+
+EF-
EO ⊕ I△O WHEN +E IN > +E OUT
+EL-
-ES+
E IN
-EL+
+EF-
EO ⊖ I△O WHEN +E IN < +E OUT
(± E IN) - (± E OUT) = ±I△O
EL = ES ±I△O
CHARGE TRANSFER
+EL-
-EF+
E IN
-EL+
+ES-
EO ⊕ I△O WHEN -E IN > -E OUT
+EL-
-EF+
E IN
-EL+
+ES-
EO ⊖ I△O WHEN -E IN < -E OUT
(± E IN) + (± E OUT) = ±I△O
EL = ES ±I△O

FIG. 12

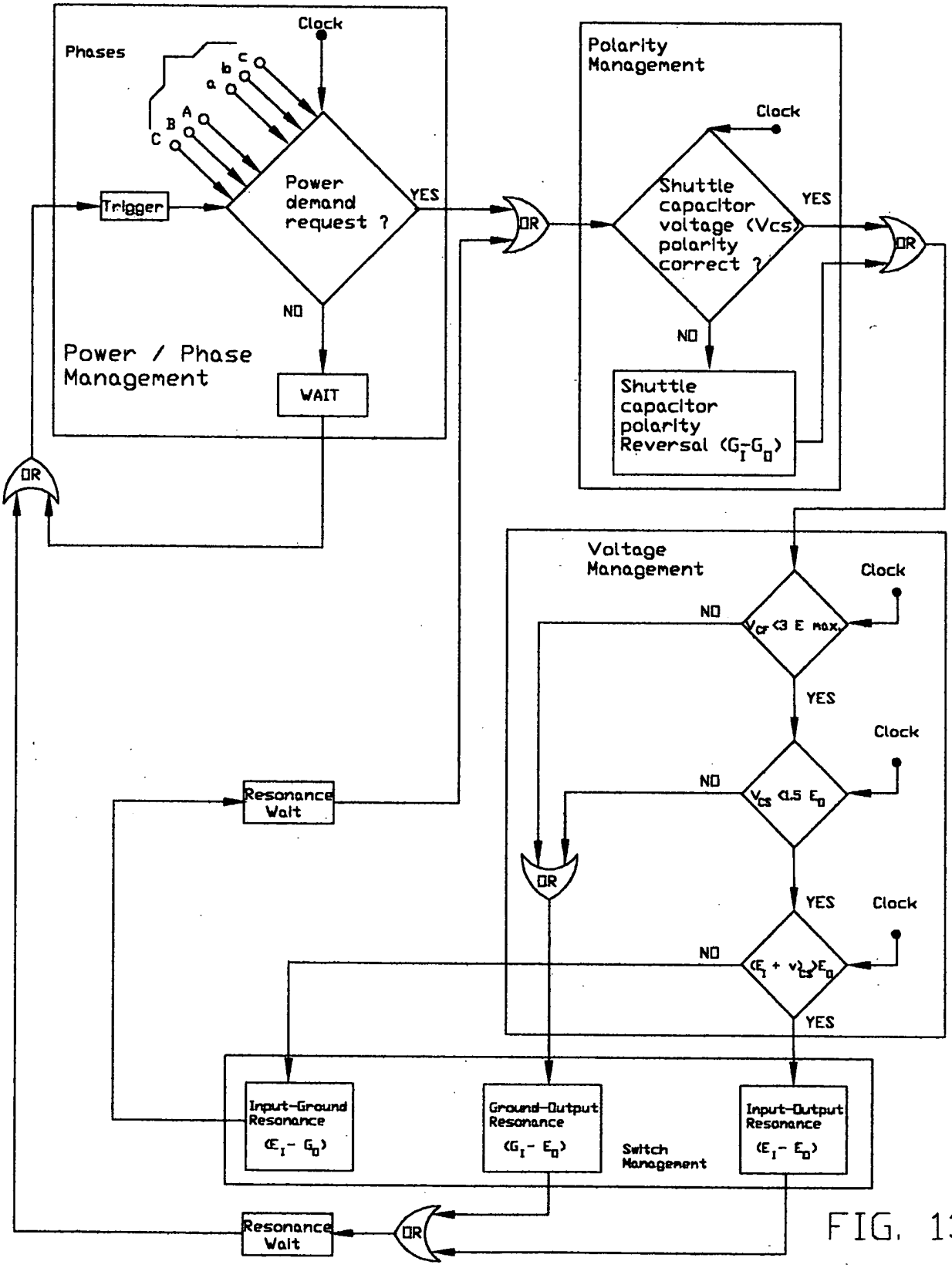

Clock
Phases
c
b
a
C
B
A
Trigger
Power demand request ?
YES
NO
Power / Phase Management
WAIT
OR
Polarity Management
Clock
Shuttle capacitor voltage (Vcs) polarity correct ?
YES
NO
Shuttle capacitor polarity Reversal (G_I-G_0)
OR
Voltage Management
Clock
NO
V_CF <3 E max.
YES
Clock
NO
V_CS <1.5 E_0
OR
YES
Clock
NO
(E_I + v)_CS E_0
YES
Resonance Wait
Input-Ground Resonance (E_I - G_0)
Ground-Output Resonance (G_I - E_0)
Input-Output Resonance (E_I - E_0)
Switch Management
Resonance Wait
OR

FIG. 13

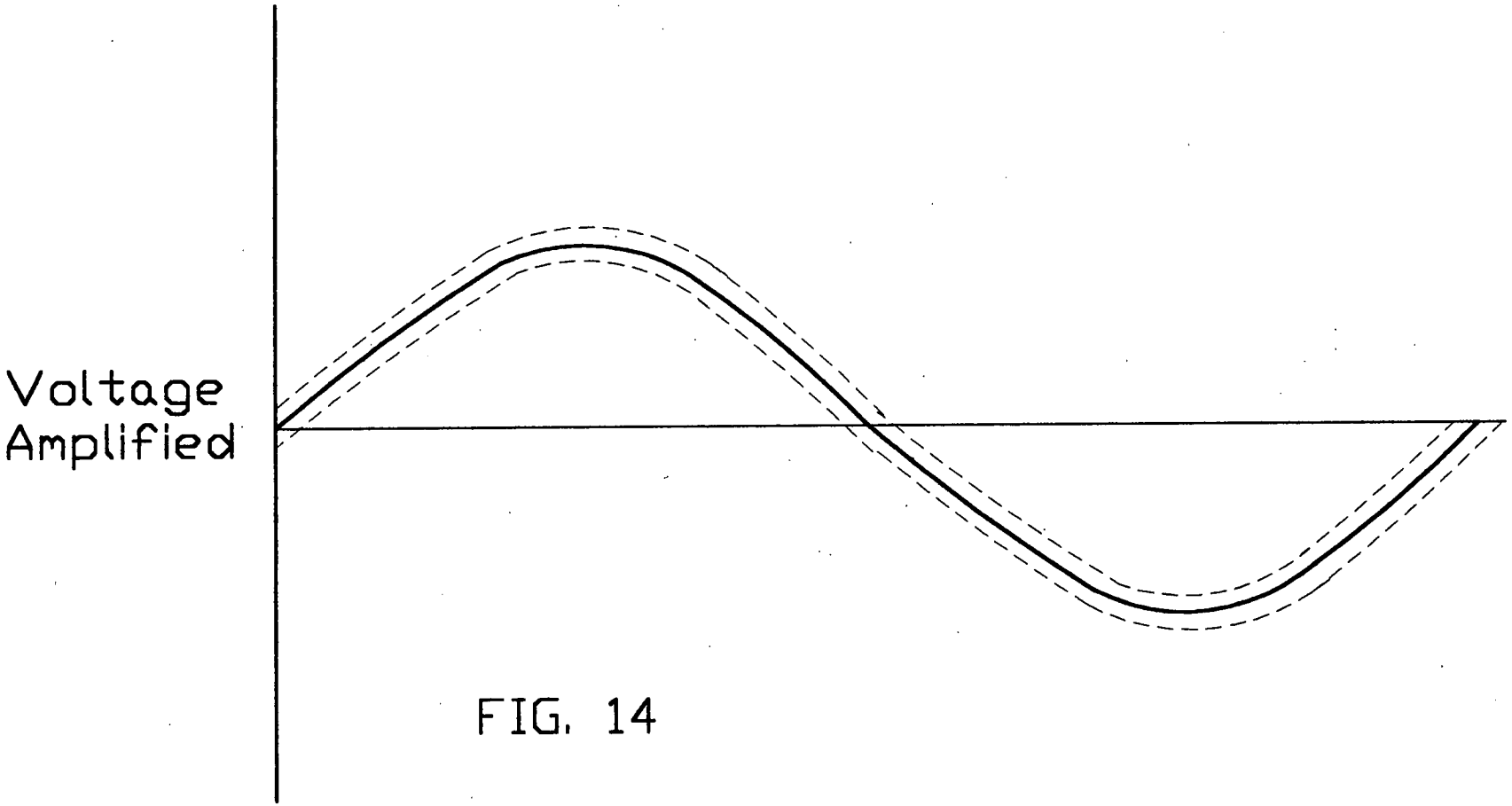


FIG. 14

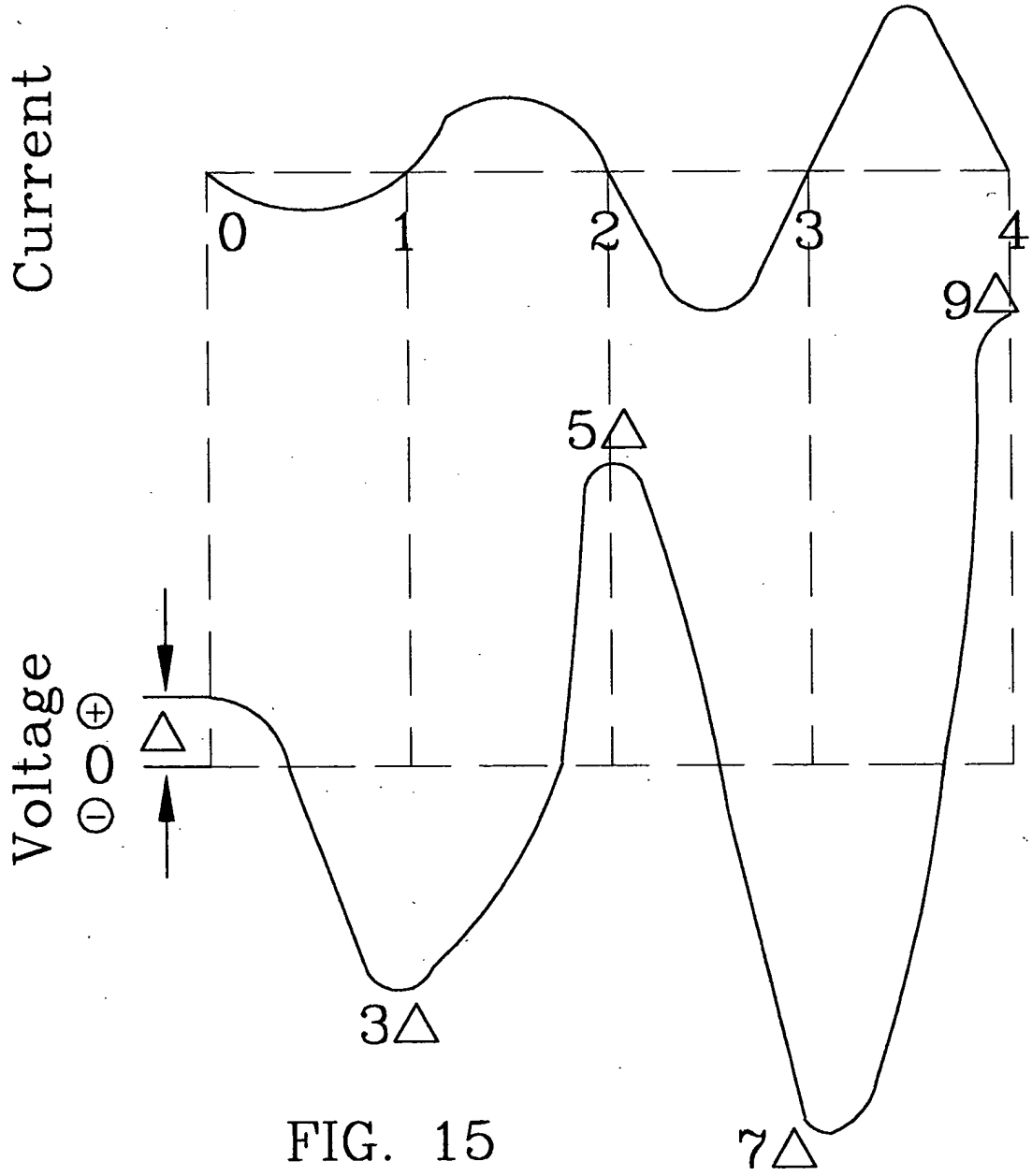


FIG. 15

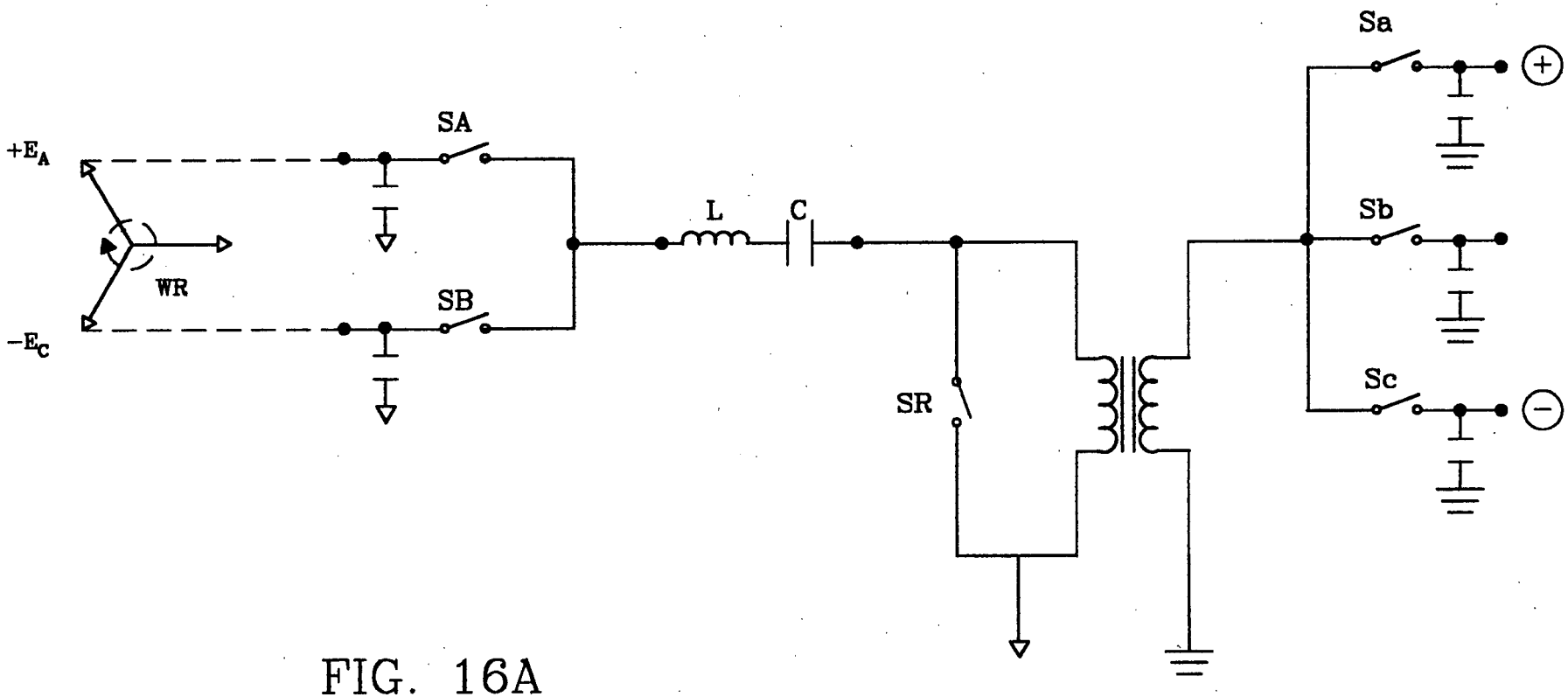


FIG. 16A

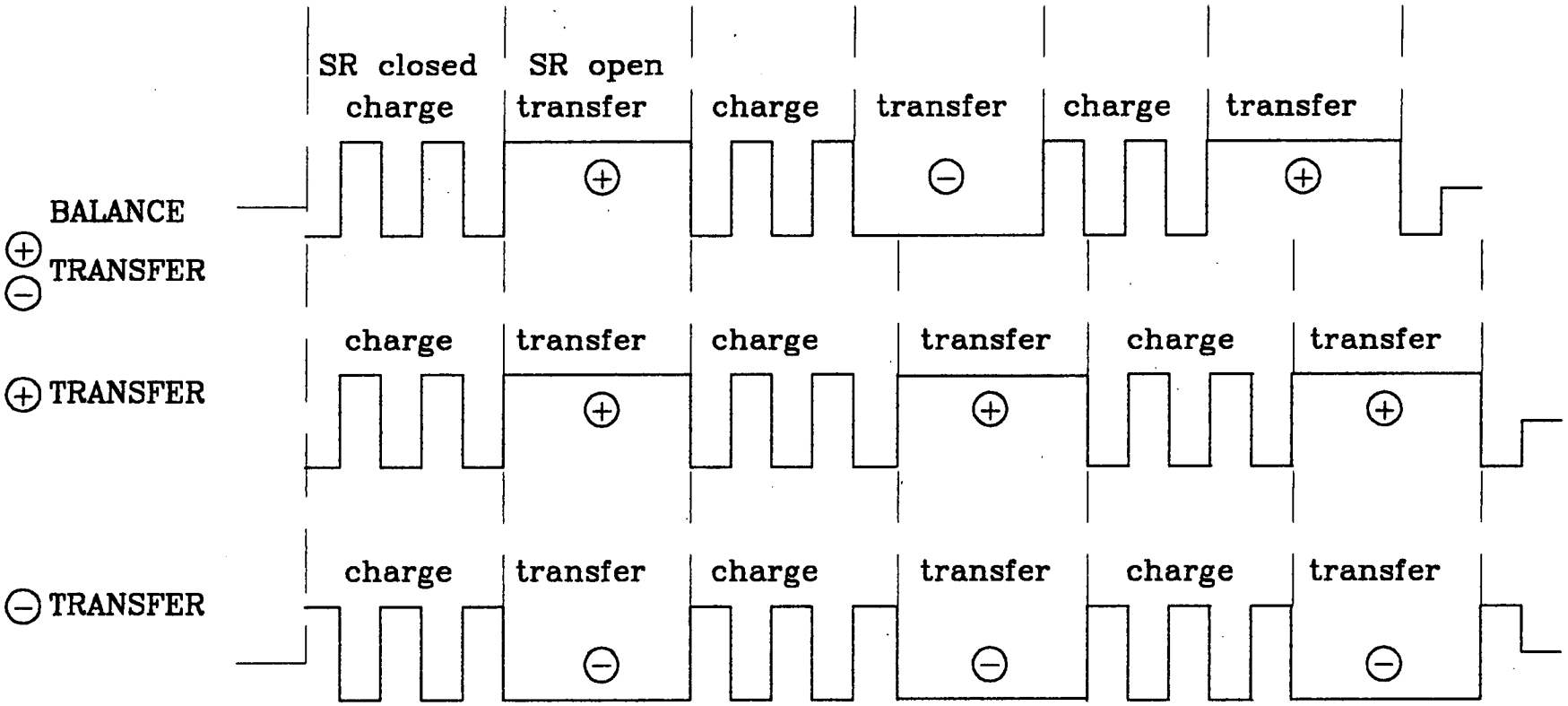

SR closed
charge
SR open
transfer
charge
transfer
charge
transfer
BALANCE
⊕ TRANSFER
⊖
charge
transfer
charge
transfer
charge
transfer
⊕ TRANSFER
charge
transfer
charge
transfer
charge
transfer
⊖ TRANSFER

FIG. 16B

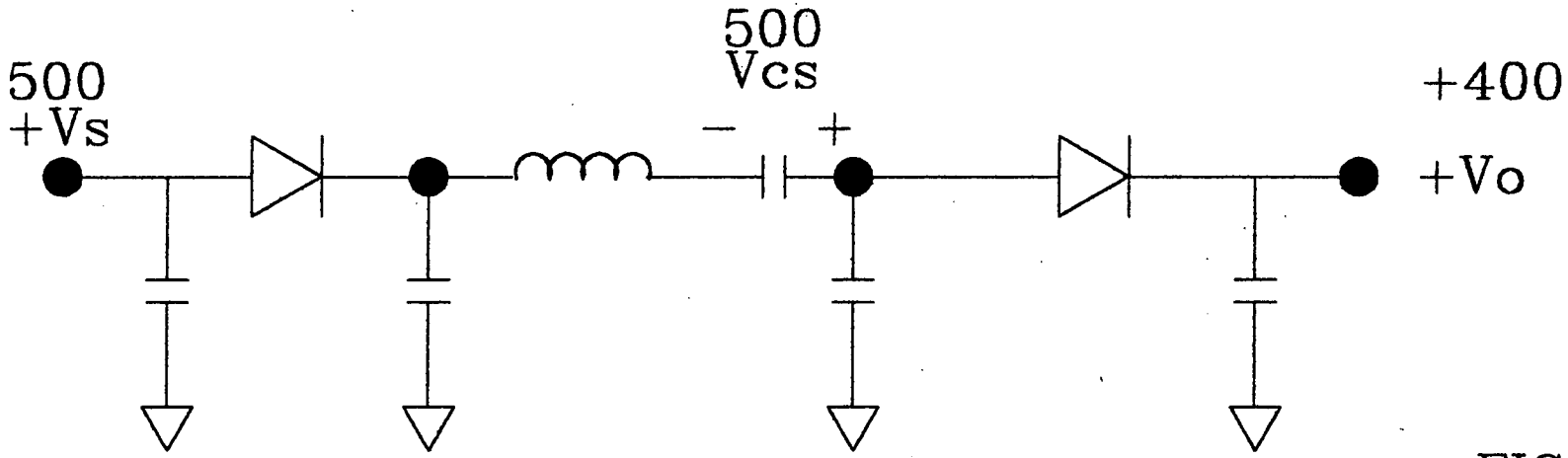


FIG. 17A

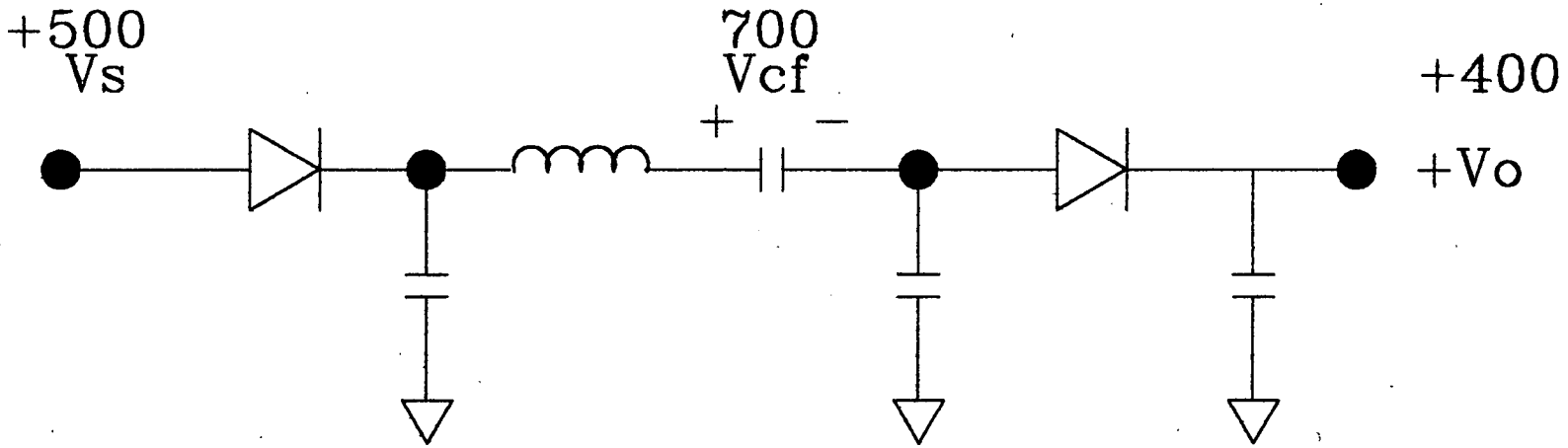
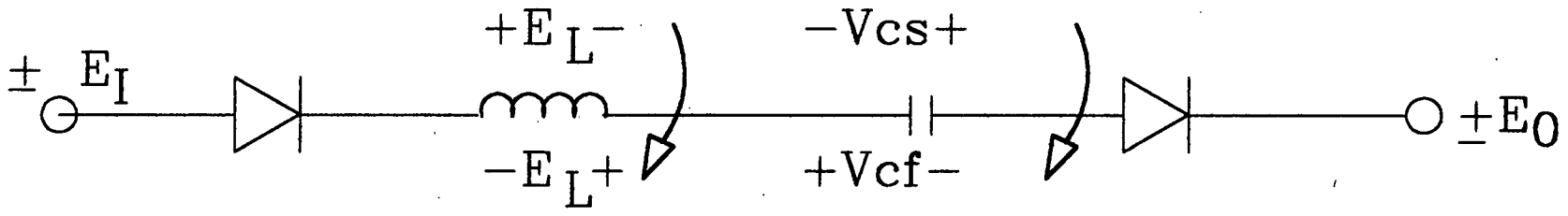
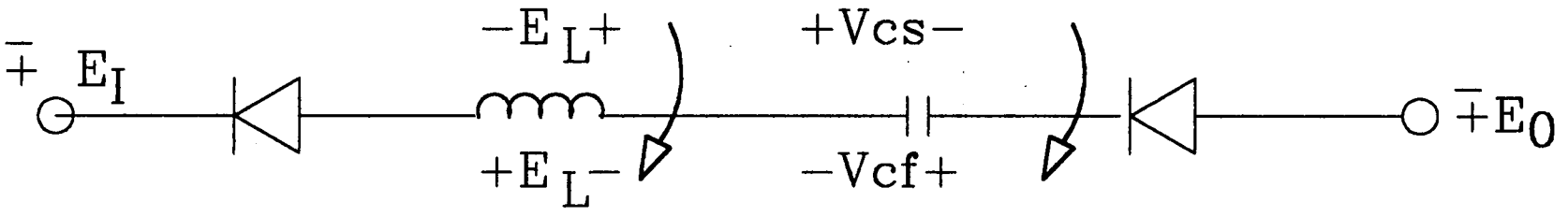


FIG. 17B



1A $(\pm E_I)-(\pm E_0)=\pm_I \Delta_0$

FIG. 18



1B $-(\mp E_I)+(\mp E_0)=\pm_I \Delta_0$

FIG. 19

2A,2B $|E_L| = |Vcs| + (\pm_I \Delta_0)$

3A,3B $|\Delta Vc| = 2 |E_L|$

Therefore

4A,4B $|\Delta Vc| = 2\{ |Vcs| \pm_I \Delta_0 \}$

5A,5B $\Delta q = C|\Delta Vc| = 2C |E_L|$

6A,6B $Iav = \Delta q$ (PRF)

FIG. 20

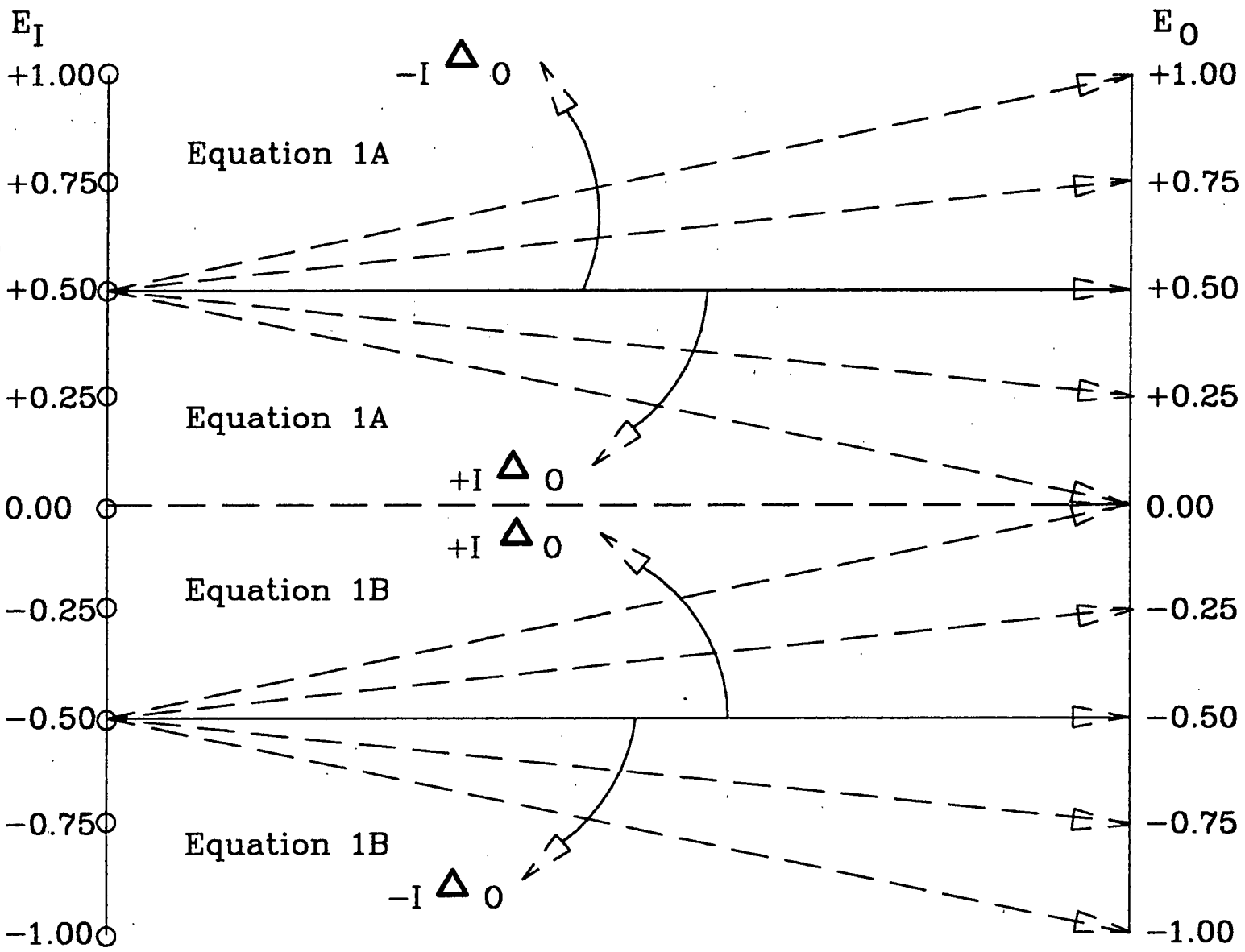
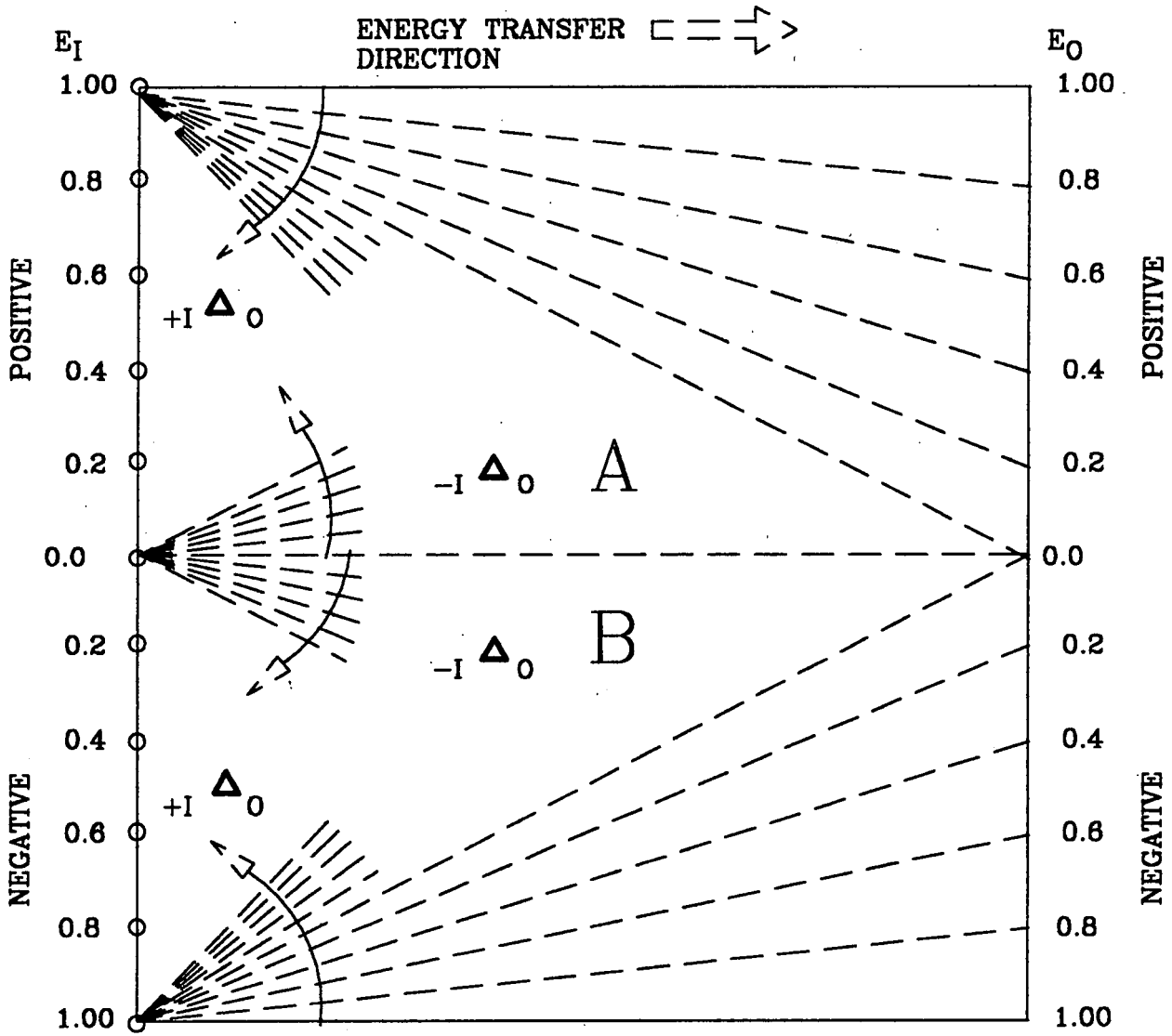

E_I
E_O
+1.00
+0.75
+0.50
+0.25
0.00
−0.25
−0.50
−0.75
−1.00
−I Δ 0
+I Δ 0
+I Δ 0
−I Δ 0
Equation 1A
Equation 1A
Equation 1B
Equation 1B

FIG. 21



A Positive input to positive or negative output ⊏⇒

B Negative input to negative or positive output ⊏⇒

FIG. 22